Lake Houston Reservoir

2018 Fisheries Management Survey Report

PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-221-M-3

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

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Contents

Survey and Management Summary

Fish populations in Lake Houston were surveyed in 2018 using electrofishing and trap netting and in 2019 using gill netting. Anglers were surveyed from March 2019 through May 2019 with a creel survey. Historical data are presented with the 2018-2019 data for comparison. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

Reservoir Description: Lake Houston is a 10,160-acre reservoir constructed on the San Jacinto River by the City of Houston in 1954 to provide water for municipal and industrial purposes. Its location within the Houston metropolitan area results in heavy recreational use.

Management History: All sport fisheries at Lake Houston are regulated under statewide length and bag limits. For several years, Palmetto Bass were stocked annually, but stockings were discontinued in 1999. Poor shallow-water habitat has limited abundance of many sport fish species, particularly Largemouth Bass. Silt loading from improper sand and gravel mining techniques in the West Fork of the San Jacinto River, upstream of the reservoir, is the primary cause of the shallow-water habitat losses. Efforts to mitigate the sedimentation include solar water circulators, native vegetation restoration, legislative action to better regulate sand and gravel mining, and dredging to mitigate the effects of Hurricane Harvey.

Fish Community

- **Prey species:** Gizzard and Threadfin Shad, Bluegill, Longear Sunfish, and Inland Silversides were the predominant prey species in Lake Houston. Prey species abundance was adequate to support sport fish.
- **Catfishes:** Blue and Channel Catfish were both present in Lake Houston, and both provided fisheries. Catfish angling was an important segment of the Lake Houston fishery, comprising 20% of all angling effort.
- **White Bass:** Gill net catches of White Bass had declined in past years, likely due to poor spring inflows needed for spawning, but increased with higher spring inflows in 2019. Past creel surveys recorded directed angling effort toward temperate bass species, but none was documented in 2013-2014 or in Spring 2019.
- **Largemouth Bass:** Genetic analysis indicates the percentage of pure Florida Largemouth Bass in Lake Houston has improved with recent stockings. Anglers seeking Largemouth Bass made up 11% of all directed angling effort.
- **Crappie:** Both Black Crappie and White Crappie occur in Lake Houston, but White Crappie were more abundant. The percentage of anglers seeking crappie and total crappie harvest increased over the last 4 years, while trap net catch has decreased since the 2013 sample.

Management Strategies: Statewide length and bag limits will continue to be used to regulate sport fish harvest. Cooperative efforts with the City of Houston and the Lake Houston Sports and Recreation Foundation (LHSRF) will continue to address water quality and habitat issues. Exotic vegetation will continue to be monitored, and TPWD will assist the City of Houston and the Coastal Water Authority with their control efforts whenever possible.

Introduction

This document is a summary of fisheries data collected from Lake Houston in 2018-2019. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve the sport fishery. While information on other fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2018-2019 data for comparison.

Reservoir Description

Lake Houston is a 10,160-acre reservoir constructed on the San Jacinto River by the City of Houston in 1954 to provide water for municipal and industrial purposes. Its location within the Houston metropolitan area results in heavy recreational use. Lake Houston has a drainage area of approximately 2,600 square miles and lies within the Piney Woods Vegetation Area. Rainfall in the watershed averages 46.6 inches per year. Conservation pool elevation is 41.73 feet above mean sea level. Quarterly elevations are reported in Figure 1. Other physical characteristics of Lake Houston are presented in Table 1.

Angler Access

Lake Houston has four public boat ramps and all ramps were available to boaters during the reporting period. Only small boats can access Ponderosa Marina from the main lake because of a low bridge on Luce's Bayou. Additional boat ramp characteristics are listed in Table 2. Shoreline access is limited to the public boat ramp areas and the shoreline at Deussen Park.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Webb and Best 2015) included:

1. Continue working with the City of Houston, other agencies, and the Lake Houston Sports and Recreation Foundation (LHSRF)/Lake Houston Friends of Reservoirs Chapter, on habitat improvement projects including native vegetation restoration. Also, continue to highlight habitat improvement projects and needs in media releases and public presentations.

    Action: The LHSRF rebuilt their native plant nursery after it was destroyed in 2017 by Hurricane Harvey. Since then, they have performed native vegetation plantings on multiple dates in 2018 and 2019. Our district continues to support LHSRF with their native aquatic plant nursery and planting efforts and have promoted cooperative projects widely since the last report via social media, traditional media, and The Dockline magazine.

2. Continue to assist the Houston Galveston Area Council with watershed management plans.

    Action: District staff have participated in West Fork of the San Jacinto River Watershed Protection Plan meetings.

3. Request stocking of Florida Largemouth Bass for Lake Houston annually to continue improving trophy potential of the Largemouth Bass population. Continue to monitor Largemouth Bass population every four years with fall electrofishing surveys and genetic analysis.

    Action: Florida Largemouth Bass were requested and stocked yearly from 2015 through 2018. Stocking requests for 2019 were denied due to the results of genetics testing following Fall 2018 electrofishing. We will continue sampling the Largemouth Bass population every four years and will continue to monitor Florida Largemouth Bass genetic influence as well. We are working to gather fin clips from larger tournament caught Largemouth Bass to aid in genetic evaluations.

4. Provide logistical support to the City of Houston regarding exotic vegetation treatment and conduct annual exotic vegetation surveys. Cooperate with the controlling authority to post appropriate signage at access points around the reservoir. Contact and educate marina owners about invasive species, and provide them with posters, literature, etc. so that they can in turn educate their customers. Educate the public about invasive species through the use of media and the internet. Make a speaking point about invasive species when presenting to constituent and user groups.

   Action: These efforts were performed and are continuous.

5. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential invasive species responses.

   Action: Kept track of progress of the Luce Bayou Interbasin Transfer Project that will connect the Trinity River Basin to the San Jacinto River Basin. The pipeline and canal system will begin in the Trinity River below Lake Livingston and will terminate in the San Jacinto River Basin (Luce Bayou) in Lake Houston.

6. Deploy Portland samplers in Lake Houston to help detect presence of zebra mussels.

   Action: Portland samplers were deployed but were lost during Hurricane Harvey.

Harvest regulation history: Crappie have been managed under a 10-inch minimum-length limit with a 25 fish daily bag since 1988. Channel and Blue Catfish were managed with a 9-inch minimum-length limit and 25 fish daily bag until 1995 when the length limit was increased to 12 inches. All other fish have been managed under statewide regulations. Current regulations are found in Table 3.

Stocking history: Soon after impoundment, Channel Catfish were stocked in Lake Houston. Palmetto Bass were stocked 13 times between 1979 and 1999 and Striped Bass were substituted for Palmetto Bass in 1989 and 1990. Florida Largemouth Bass were stocked in 1990 and in 2013-2018 by TPWD, and in 2012 by the Lake Houston Sports and Recreation Foundation. A complete stocking history is presented in Table 4.

Vegetation/habitat management history: Historically, Lake Houston has had limited littoral habitat. Heavy silt loading in the upper reaches of the reservoir has inhibited the growth of desirable aquatic vegetation; however, with regulation of gravel mining upstream from Lake Houston and native aquatic vegetation restoration projects in the reservoir, the conditions are improving. In recent years, Lake Houston has been infested with nuisance aquatic plants such as common salvinia, water hyacinth, and water lettuce. TPWD provided annual funding to the Coastal Water Authority (CWA) for exotic vegetation control. In September 2018, the Army Corps of Engineers began dredging the West Fork of the San Jacinto River to remove sediment washed into the waterway by Hurricane Harvey. The project is funded by FEMA and aims to remove 1-3 million cubic yards of sediment from a two-mile area near the West Lake Houston Parkway Bridge. The goal was to restore the San Jacinto to pre-Harvey conditions by May 2019, but the recent addition of a fourth section to the dredging project (the sand bar at the mouth of the river) will prolong dredging activities in the reservoir.

Water transfer: Lake Houston is used for municipal water supply and recreation. There is currently one water treatment facility on the reservoir that provides municipal water for the City of Houston. A project is underway to transfer water from the Trinity River below Lake Livingston to Lake Houston (San Jacinto River Drainage) by way of the Luce Bayou canal.

Methods

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Lake Houston (Webb and Best 2015). Primary components of the OBS plan are listed in Table 5. Electrofishing sites were biologist chosen, trap netting and gill netting sites were randomly selected, and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Electrofishing – Largemouth Bass, sunfishes, Gizzard Shad, and Threadfin Shad were collected by daytime electrofishing (2 hours at 24, biologist-selected, 5-min stations). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing. Ages for Largemouth Bass were determined using otoliths from 8 randomly-selected fish (range 13.0 to 14.9 inches).

Trap netting – Crappie were collected using trap nets (15 net nights at 15 stations). CPUE for trap netting was recorded as the number of fish caught per net night (fish/nn). Ages for crappie were determined using otoliths from 11 randomly-selected White Crappie and 6 randomly-selected Black Crappie (range 9.0 to 10.9 inches).

Gill netting – Channel Catfish, Blue Catfish, and White Bass were collected by gill netting (15 net nights at 15 stations). CPUE for gill netting was recorded as the number of fish caught per net night (fish/nn).

Genetics – Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017). Micro-satellite DNA analysis was used to determine genetic composition of individual fish.

Statistics – Sampling statistics (CPUE for various length categories), structural indices [Proportional Size Distribution (PSD), terminology modified by Guy et al. 2007], and condition indices [relative weight (W_r)] were calculated for target fishes according to Anderson and Neumann (1996). Index of Vulnerability (IOV) was calculated for Gizzard Shad (DiCenzo et al. 1996). Standard error (SE) was calculated for structural indices and IOV. Relative standard error (RSE = 100 X SE of the estimate/estimate) was calculated for all CPUE and creel statistics.

Creel survey – A spring-quarter roving creel survey was conducted in 2019. The creel period was March through May. Angler interviews were conducted on 5 weekend days and 4 weekdays to assess angler use and fish catch/harvest statistics in accordance with the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Habitat – A structural habitat survey was conducted in 2018. Vegetation surveys were conducted in 2016-2019 to monitor exotic vegetation. Habitat was assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Water level – Source for water level data was the United States Geological Survey (USGS 2019).

Results and Discussion

Habitat: Bulkhead construction covers about 30% of the shoreline (Table 6). Native vegetation occupied approximately 3% of total surface acres of Lake Houston in 2018 (Table 7). Non-native (invasive) species for the 2016-2019 period included common salvinia, water hyacinth, water lettuce, alligator weed, and elephant ear. No common salvinia was found in 2018 or 2019, but the other four species covered approximately 53 acres in 2018, and water hyacinth and water lettuce covered a combined 70 acres in 2019.

Creel: The most sought-after species on Lake Houston were crappies with anglers spending an estimated 26,875 hours (43% of total directed fishing effort) of directed fishing effort (Tables 8 and 14). Catfish were the second most popular group with approximately 21% of total directed effort (similar to the 23% seen in 2014). Largemouth Bass comprised 11% of the total effort (a decrease from 30% in 2014) (Table 8). Approximately 26% of anglers fished for "anything" during the 2019 creel. Total angler effort increased from 9,478 hours in 2014 to 62,839 hours in 2019, and anglers spent an estimated $217,242 in 2019 compared to $77,188 in 2014 (Table 9).

Prey species: Gizzard Shad, Threadfin Shad, Bluegill, Longear Sunfish, and Inland Silversides were major forage species in Lake Houston. IOV for Gizzard Shad was 96, indicating most Gizzard Shad were available to predators (Figure 2). The electrofishing catch rate was 789/h for Gizzard Shad and Threadfin Shad combined, 60/h for Bluegill (Figure 3), 79/h for Longear Sunfish, and 30/h for Inland Silversides (Appendix A).

Catfish: Both Blue Catfish and Channel Catfish occur in Lake Houston, and both provide popular fisheries. Gill net CPUE for Blue Catfish in 2019 was 9.5/nn, down from 14.8/nn in 2015 (Figure 4). Fish up to 40 inches in length were captured in gill nets. Gill net CPUE of Channel Catfish was 11.1/nn, down from 18.9/nn in 2015 (Figure 5). Body condition (W_r) of both Blue and Channel Catfish was good ($W_r >$ 85 for all stock-size length classes), indicating adequate forage availability. Anglers harvested an estimated 1,820 Blue Catfish and 7,446 Channel Catfish (Table 10). Blue Catfish and Channel Catfish up to 32 and 22 inches, respectively, were observed during the 2019 creel period (Figures 6 and 7). Angling effort for catfishes and estimated harvest of each species increased from the 2014 creel (Table 10).

White Bass: Gill net catch rates of White Bass were low in 2019 (1.3/nn), but higher than in 2015 (0.3/nn) (Figure 8). No anglers targeted White Bass during the 2019 creel period (Table 11), but six White Bass ranging from 13-17 inches were observed in the creel (Figure 9).

Largemouth Bass: Historically, electrofishing catch rates of Largemouth Bass at Lake Houston have been low due to habitat degradation. The electrofishing CPUE in 2018 was 26.5/h, down from 46.0/h in 2014 but still higher than 2010 rates (9.5/h) (Figure10). Body condition was good in 2018 (relative weights above 90) for all length classes and was similar to body condition in previous surveys (Figure 10). Average age of Largemouth Bass at 14 inches (13.0-14.9 inches) was 2.5 years (N = 8; range = 2-5 years) (Figure 11). During the period from March 2019 through May 2019, anglers spent an estimated 6,602 hours seeking Largemouth Bass (Table 12) and did not harvest any Largemouth Bass, releasing 100% of legal-sized fish caught. One pure Florida Largemouth Bass was detected in the 2018 sample and the Florida allele frequency was 13.0% (Table 13).

Crappie: Both White Crappie and Black Crappie were present in Lake Houston although White Crappie were more numerous. Trap net sampling in 2018 captured 2.9 White Crappie and 0.8 Black Crappie per net night (Figures 13 and 14). Average age of White Crappie at 10 inches (9.0-10.9 inches) was 1.8 years (N = 11; range = 1-4 years), and average age of Black Crappie at 10 inches (9.0-10.9 inches) was 4.3 (N = 6; range = 3-6 years) (Figures 15 and 16). Anglers harvested an estimated 11,280 White Crappie and 2,515 Black Crappie during the 2019 creel period. Catch rate for both species combined was 0.9 fish per hour. Only 2.2% of legal fish caught by anglers were released (Table 14). White Crappie and Black Crappie up to 14 and 16 inches respectively were observed during the 2019 creel survey (Figures 17 and 18).

Fisheries Management Plan for Lake Houston, Texas
Prepared – July 2019

ISSUE 1: There is little littoral habitat available for Largemouth Bass reproduction and growth throughout the reservoir, which was exacerbated by Hurricane Harvey. Since Harvey, the LHSRF/Lake Houston Friends of Reservoirs Chapter has rebuilt their native vegetation nursery and has conducted plantings in 2018 and 2019 to attempt to regain what was lost.

MANAGEMENT STRATEGY

1. Continue working with LHSRF/Lake Houston Friends of Reservoirs Chapter on new and ongoing habitat and vegetation projects.

ISSUE 2: Little to no increase in Florida Largemouth Bass genetic influence was seen despite stocking Florida strain fingerlings for several years in a row (2013-2018).

MANAGEMENT STRATEGIES

1. Work with tournament anglers to collect fin clips from tournament fish greater than 4 pounds for genetic analysis.

2. Work with tournament directors, boat ramp owners, and LHSRF to encourage anglers to submit any qualifying bass to the ShareLunker program and to submit scales for genetic analysis.

ISSUE 3: There is limited access for shoreline anglers on Lake Houston. Current public access is limited to the public boat ramp areas and the shoreline at Deussen Park

MANAGEMENT STRATEGY

1. Work with LHSRF/Lake Houston Friends of Reservoirs Chapter on fundraising efforts to construct an Americans with Disabilities Act (ADA) compliant fishing pier at Deussen Park.

ISSUE 4: Many invasive species threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels (*Dreissena polymorpha*) can multiply rapidly and attach themselves to any available hard structure, restricting water flow in pipes, fouling swimming beaches, and plugging engine cooling systems. Giant salvinia (*Salvinia molesta*) and other invasive vegetation species can form dense mats, interfering with recreational activities like fishing, boating, skiing, and swimming. The financial costs of controlling and/or eradicating these types of invasive species are significant. Additionally, the potential for invasive species to spread to other river drainages and reservoirs via watercraft and other means is a serious threat to all public waters of the state

MANAGEMENT STRATEGIES

1. Cooperate with the controlling authority to post appropriate signage at access points around the reservoir.

2. Contact and educate marina owners about invasive species, and provide them with posters, literature, etc. so that they can in turn educate their customers.

3. Educate the public about invasive species through the use of media and the internet.

4. Make a speaking point about invasive species when presenting to constituent and user groups.

5. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential invasive species responses.

Objective-Based Sampling Plan and Schedule (2019–2023)

Sport fishes in Lake Houston include Blue Catfish, Channel Catfish, White Bass, Largemouth Bass, Black Crappie, and White Crappie. Important forage species include Gizzard Shad, Threadfin Shad, and Bluegill.

All sport species at Lake Houston contribute to the overall fishery and justify sampling effort.

A complete sampling schedule is listed in Table 15.

Crappie

During the 2019 spring-quarter creel survey crappie anglers represented 43% of the directed angler effort at Lake Houston. Although both White and Black Crappie were harvested, White Crappie were the most abundant in both trap netting surveys and angler creels. Based on bootstrap analysis of historical data, it would take 15 trap nets to attain acceptable precision and catch of stock-length fish (RSE < 25, N > 50) at least 80% of the time for White Crappie. White Crappie trend data (CPUE, PSD, W_r) will be monitored during the fall of 2022 in order to detect any larger scale population fluctuations. Trend data will be measured with 15 single-cod shoreline trap net sets at randomly selected sites, which should be sufficient effort to achieve an RSE < 25 of CPUE-total and collect at least 50 stock-size individuals. Black Crappie data will be used to show presence/absence since this is a very minor part of the crappie fishery. Fifteen trap net nights will be the maximum effort expended, and a spring-quarter creel survey will be used to provide supplemental population data.

White Bass

White Bass are present within the reservoir, but no directed angling effort was documented in the 2019 spring-quarter creel survey. Bootstrap analysis of historic data suggests over 15 randomly-selected gill net nights would be required to obtain reliable CPUE values (i.e. RSE < 25 for CPUE-total) and to collect 50 stock sized fish for size structure, age and growth, or body condition analysis. Since White Bass are targeted by such a small percentage of anglers our sampling objective is to determine presence/absence of White Bass in spring 2023 gill netting in conjunction with the catfish sampling efforts using15 gill net nights at randomly selected sites. No additional sampling to determine White Bass presence/absence will occur above that conducted for catfish sampling objectives.

Catfish

Blue and Channel Catfishes combined accounted for 21% of directed angler effort during the 2019 spring-quarter creel survey. Based on bootstrap analysis of historical data 15 gill nets should obtain data with an acceptable precision and catch (CPUE-total, RSE < 25, N > 50) at least 80% of the time for both Blue and Channel Catfish. Blue and Channel Catfish trend data (CPUE, PSD, W_r) will be monitored during the

spring of 2023 with gill nets in order to detect any large-scale population fluctuations. Trend data will be surveyed with 15 gill net nights at randomly selected sites, which should be sufficient effort to achieve a CPUE-total RSE < 25 and collect at least 50 stock size individuals. Fifteen gill net nights will be the maximum effort expended, and a spring-quarter creel survey will be used to provide supplemental population data.

Largemouth Bass

Largemouth Bass abundance is limited by turbidity and the commensurate lack of submersed aquatic vegetation; however, the Largemouth Bass fishery at Lake Houston is popular, accounting for 11% of the total directed angling effort during the 2019 spring-quarter creel survey and 30% during the 2014 spring-quarter creel survey. Bootstrap analysis of historic data suggests reliable population metrics (CPUE-Stock; RSE < 50 stock-size individuals) would require well over 24 randomly selected 5-minute electrofishing stations. Our survey objective is to continue monitoring population trend data on relative abundance, size structure, body condition, growth, genetics, and angling effort, catch, and harvest of Largemouth Bass every four years with fall electrofishing and a spring quarter creel survey. This will allow for the detection of any large-scale fluctuations in the Largemouth Bass population that may warrant further investigation. Our sampling objective is to collect at least 50 stock-size Largemouth Bass by sampling 24 biologist-selected electrofishing sites (daytime sampling). If stated effort is inadequate to achieve the sampling objective, and a spring-quarter creel survey will be used to provide supplemental population data.

Forage Species

Gizzard Shad, Threadfin Shad, and Bluegill are the primary forage species at Lake Houston. Based on sampling history, fall electrofishing generally provides adequate data to evaluate the overall forage base at Lake Houston; therefore, our survey objective is to monitor long term trends in size structure and relative abundance of these important forage species. For size structure, our sampling objective is to collect 50 individuals for PSD and IOV of Gizzard Shad and PSD of Bluegill with sampling effort used to meet Largemouth Bass sampling objectives. No additional sampling will occur beyond what is done to meet Largemouth Bass sampling objectives.

Creel Survey

A stratified roving angler creel survey will be conducted March 1, 2023 – May 31, 2023 to estimate directed angling effort, catch, harvest, and expenditures for all game fish species. This is a general monitoring creel survey that intends to capture information about all species sought by anglers, economic expenditures, travel distances for anglers, and angling pressure on Lake Houston fisheries.

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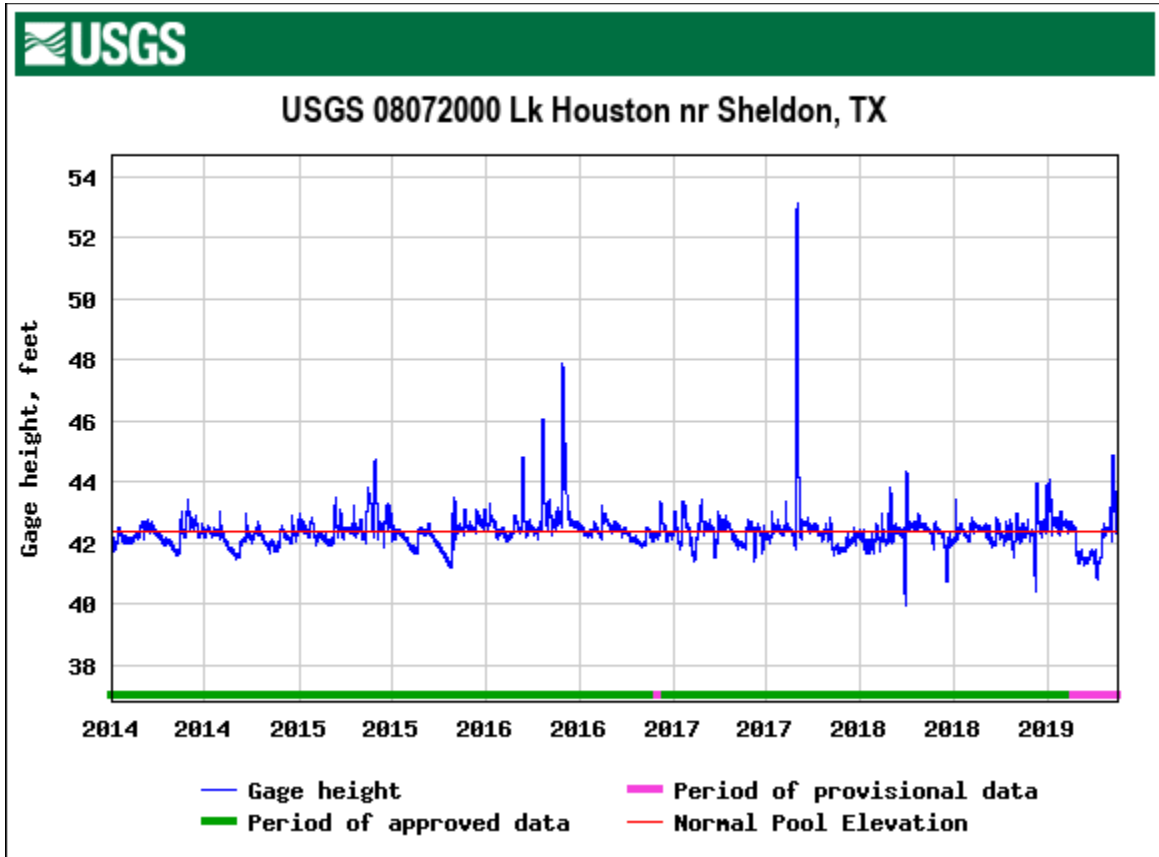
Tables and Figures

Figure 1. Daily water level elevations in feet above mean sea level (MSL) recorded for Lake Houston, Texas, January 2014 – May 2019.

Table 1. Characteristics of Lake Houston, Texas.

Characteristic	Description
Year constructed	1954
Controlling authority	City of Houston
County	Harris (location of dam)
Reservoir type	Mainstream
Shoreline Development Index	10.1
Conductivity	151 µS/cm

Table 2. Boat ramp characteristics for Lake Houston, Texas, August 2018. Reservoir elevation at time of survey was 42.5 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft)	Condition
Alexander Deussen Park	29.91687 -95.14800	Y	260	39	2 boat ramps with 8 lanes plus a 1 lane small boat ramp. Excellent condition.
Lake Houston Marina	30.01868 -95.11914	Y	45	40	1 boat ramp with 2 lanes. Excellent condition.
Ponderosa Marina	30.05640 -95.14800	Y	30	41	1 boat ramp with 2 lanes. Good condition but a low-clearance bridge on Luces' Bayou prevents access to main reservoir by large boats.
BJ's Marina	29.916875 -95.148003	Y	30	41	1 boat ramp with 2 lanes. Good condition.

Table 3. Harvest regulations for Lake Houston, Texas.

Species	Bag limit	Length limit
Catfish: Channel and Blue Catfish, their hybrids and subspecies	25 (in any combination)	12-inch minimum
Catfish, Flathead	5	18-inch minimum
Bass, White	25	10-inch minimum
Bass, Largemouth	5[a]	14-inch minimum
Bass, Spotted	5[a]	None
Crappie: White and Black Crappie, their hybrids and subspecies	25 (in any combination)	10-inch minimum

[a] Daily bag for Largemouth Bass and Guadalupe Bass = 5 fish in any combination.

Table 4. Stocking history of Lake Houston, Texas. UNK = unknown; FRY = fry; FGL = fingerling; AFGL = advanced fingerling.

Species	Year	Number	Size
Channel Catfish	1972	132,724	AFGL
	1973	35,000	AFGL
	Total	167,724	
Florida Largemouth Bass	1990	306,965	FRY
	2013	100,370	FGL
	2014	99,463	FGL
	2015	76,260	FGL
	2016	80,041	FGL
	2017	50,195	FGL
	2018	74,801	FGL
	Total	788,095	
Palmetto Bass	1979	123,200	UNK
	1981	135,638	UNK
	1983	122,459	UNK
	1984	362,450	FGL
	1986	237,083	FGL
	1986	123,932	FRY
	1991	134,600	FGL
	1992	103,180	FGL
	1994	62,000	FGL
	1995	187,650	FGL
	1996	122,416	FGL
	1997	61,351	FGL
	1998	63,236	FGL
	Total	1,839,195	
Striped Bass	1989	246,000	FGL
	1990	122,879	FGL
	Total	368,879	

Table 5. Objective-based sampling plan components for Lake Houston, Texas 2018-2019.

Gear/target species	Survey objective	Metrics	Sampling objective
Electrofishing			
Largemouth Bass	Abundance	CPUE–Stock	RSE-Stock ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Age-and-growth	Age at 14 inches	N = 13, 13.0 – 14.9 inches
	Condition	W_r	10 fish/inch group (max)
	Genetics	% FLMB	N = 30, any age
Bluegill [a]	Abundance	CPUE–Total	RSE ≤ 25
	Size structure	PSD, length frequency	N ≥ 50
Gizzard Shad [a]	Abundance	CPUE–Total	RSE ≤ 25
	Size structure	PSD, length frequency	N ≥ 50
	Prey availability	IOV	N ≥ 50
Gill Netting			
Blue Catfish	Abundance	CPUE–stock	RSE-Stock ≤ 25
	Size structure	Length frequency	N ≥ 50 stock
	Condition	W_r	10 fish/inch group (max)
Channel Catfish	Abundance	CPUE–stock	RSE-Stock ≤ 25
	Size structure	Length frequency	N ≥ 50 stock
	Condition	W_r	10 fish/inch group (max)
Trap netting			
Crappie	Size structure	PSD, length frequency	N = 50
	Age-and-growth	Age at 10 inches	N = 13, 9.0 – 10.9 inches
	Condition	W_r	10 fish/inch group (max)

[a] No additional effort will be expended to achieve an RSE ≤ 25 for CPUE of Bluegill and Gizzard Shad if not reached from designated Largemouth Bass sampling effort. Instead, Largemouth Bass body condition can provide information on forage abundance, vulnerability, or both relative to predator density.

Table 6. Survey of structural habitat types, Lake Houston, Texas, 2018. Shoreline habitat type units are in miles and standing timber is acres.

Habitat type	Estimate	% of total
Bulkhead with open water	5.5	5.2
Bulkhead with piers and boat docks	24.7	23.4
Bulkhead with dead timber	1.9	1.8
Concrete with open water	3.7	3.5
Eroded bank with concrete	0.4	0.4
Eroded bank with dead timber	7.1	6.7
Eroded bank with piers and docks	0.9	0.9
Eroded banks with standing timber	0.9	0.9
Overhanging brush with dead timber	36.5	34.3
Overhanging brush with standing timber	23.8	22.3
Riprap with dead timber	0.5	0.5
Riprap with open water	0.5	0.5
Rocky shoreline with piers and docks	0.1	0.1

Table 7. Survey of aquatic vegetation, Lake Houston, Texas, 2016-2018. Surface area (acres) is listed with percent of total reservoir surface area in parentheses.

Vegetation	2016	2017	2018
Native submersed			0 (0)
Native floating-leaved			52.1 (0.4)
Native emergent			337.5 (2.8)
Total Native			389.6 (3.2)
Non-native*			
Common salvinia (Tier II)**	28 (0.2)	4 (0)	0 (0)
Water hyacinth (Tier II)**	21 (0.2)	55 (0.4)	24 (0.2)
Water lettuce (Tier II)	0 (0)	0 (0)	24 (0.2)
Alligator weed (Tier III)	0 (0)	0 (0)	4.4 (0)
Elephant ear (Tier III)	0 (0)	0 (0)	0.2 (0)
Total Non-native	49 (0.4)	59 (0.5)	52.6 (0.4)

*Non-native vegetation data provided by the Coastal Water Authority
**Tier I is immediate Response, Tier II is Maintenance Status, Tier III is Watch Status

Table 8. Percent directed angler effort by species for Lake Houston, Texas, 2011-2019. Survey periods were from 1 March through 31 May for 2011, 2014, and 2019.

Species	2011	2014	2019
Catfishes	4.1	22.9	21.1
Temperate Bass	0	0	0
Sunfishes	0	0	0
Black Bass	16.3	29.6	10.5
Crappies	73.3	4.9	42.8
Anything	6.2	42.6	25.6

Table 9. Total fishing effort (h) for all species and total directed expenditures at Lake Houston, Texas, 2011-2019. Survey periods were from 1 March through 31 May for 2011, 2014, and 2019. Relative standard error is in parentheses.

Creel statistic	2011	2014	2019
Total fishing effort	16,528.7 (40.8)	9,478.0 (22.6)	62,838.6 (40.3)
Total directed expenditures	$82,360 (63.8)	$77,188 (70.4)	$217,242 (52.5)

Gizzard Shad

2010

Effort = 2.0
Total CPUE = 103.0 (19; 206)
IOV = 92 (2)

2014

Effort = 2.0
Total CPUE = 96.0 (32; 192)
IOV = 90 (4)

2018

Effort = 2.0
Total CPUE = 96.0 (23; 192)
IOV = 96 (3)
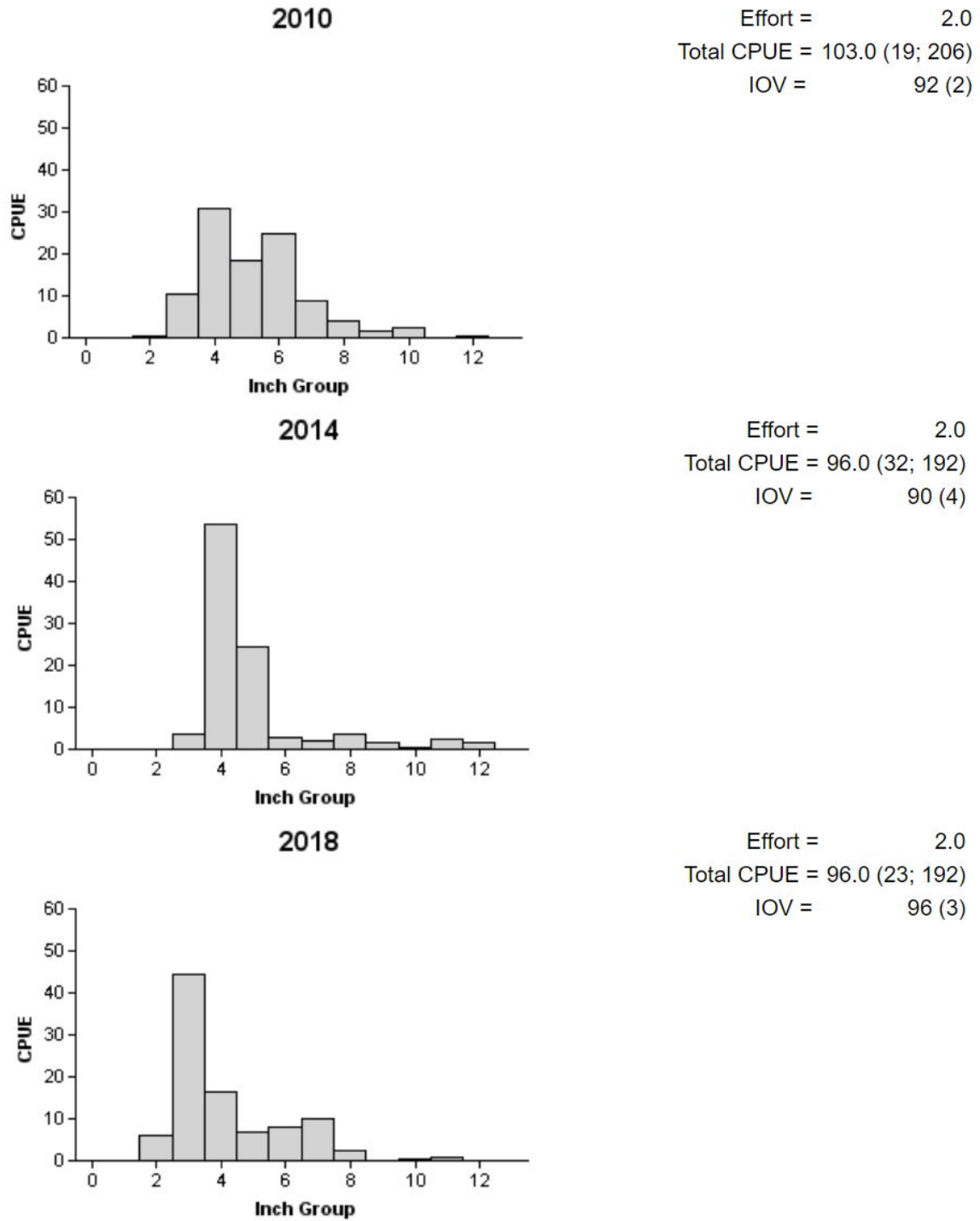
Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Lake Houston, Texas, 2010, 2014, and 2018.
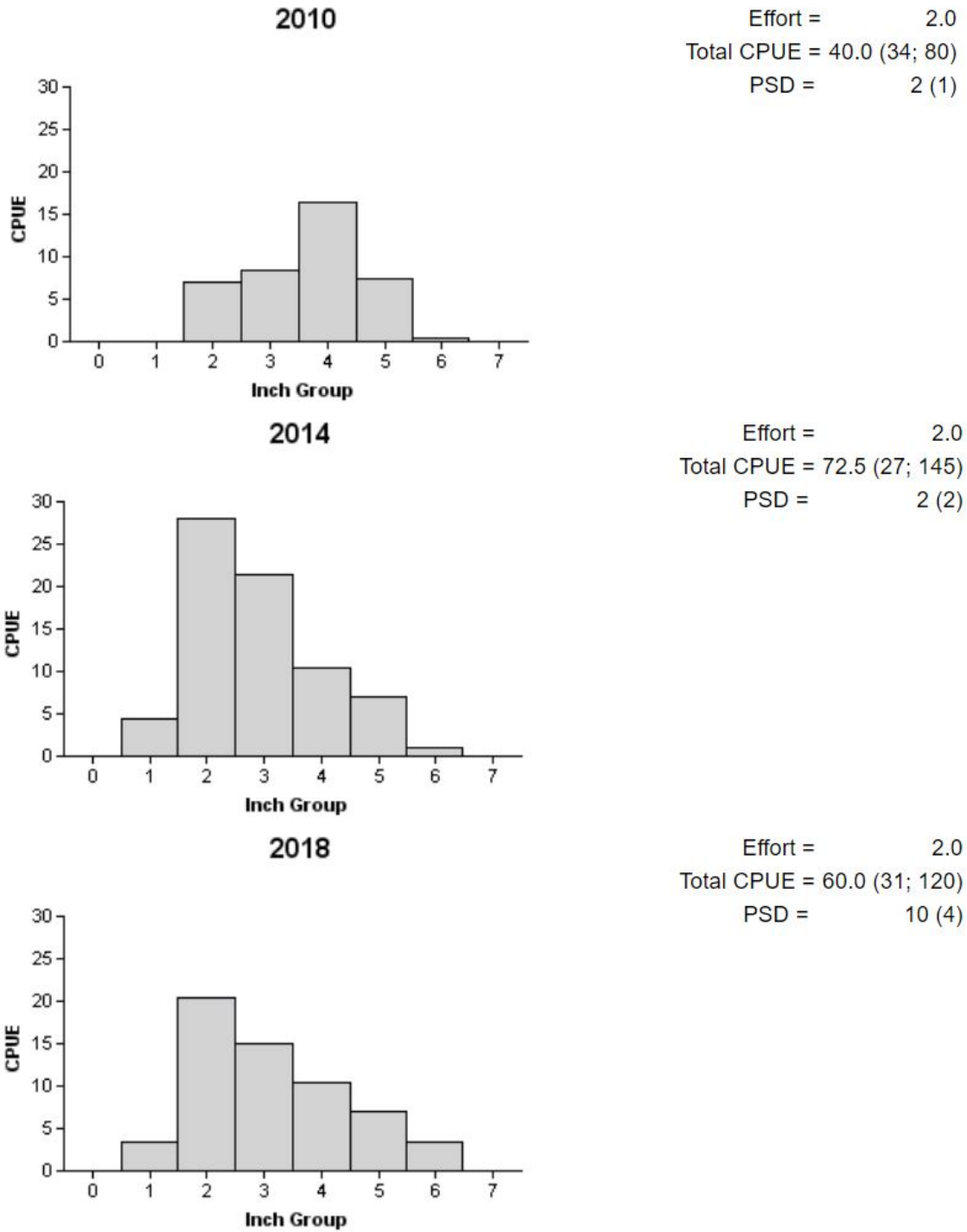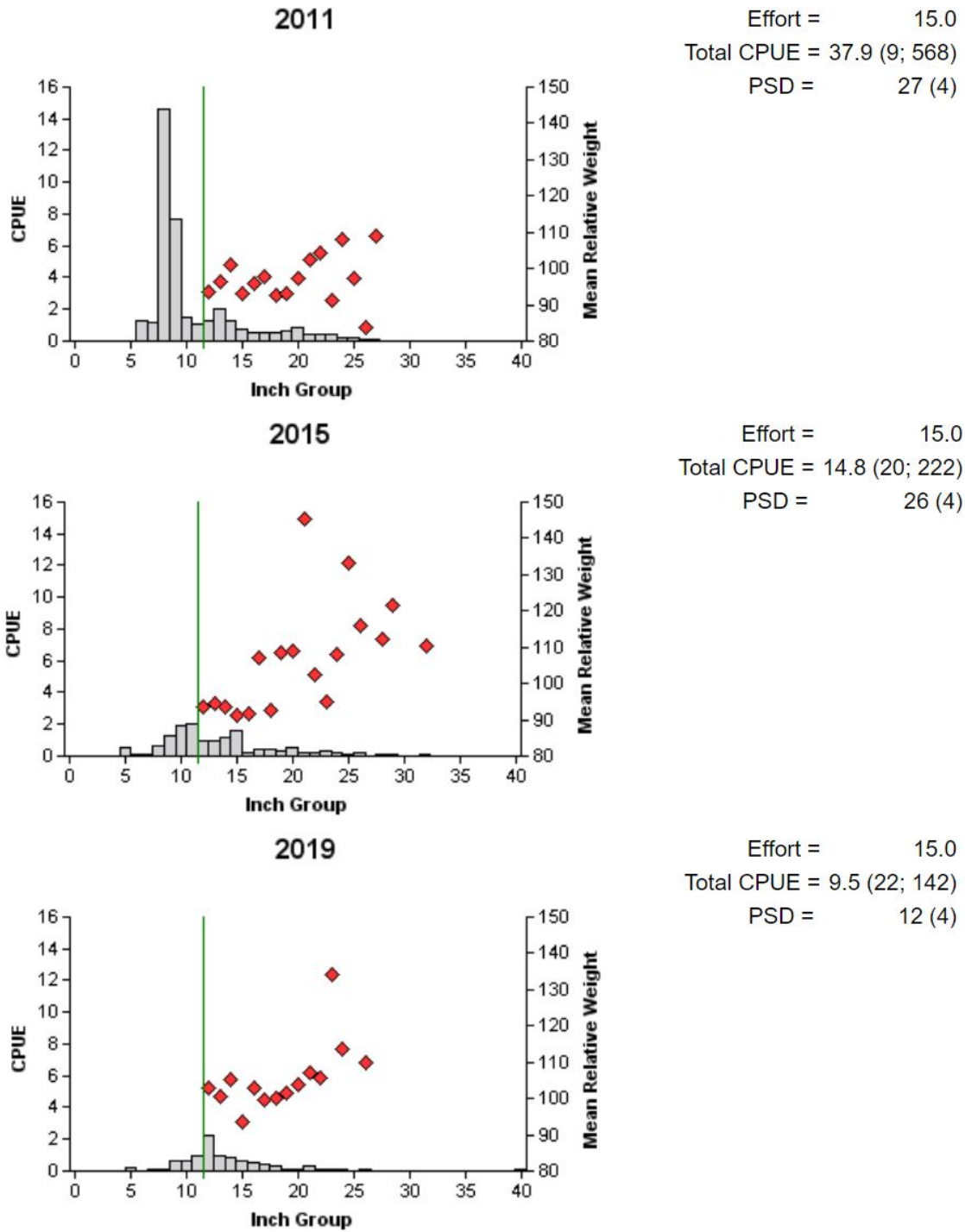
Bluegill

2010

Effort = 2.0
Total CPUE = 40.0 (34; 80)
PSD = 2 (1)

2014

Effort = 2.0
Total CPUE = 72.5 (27; 145)
PSD = 2 (2)

2018

Effort = 2.0
Total CPUE = 60.0 (31; 120)
PSD = 10 (4)

Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Lake Houston, Texas, 2010, 2014, and 2018.

Blue Catfish

2011

Effort = 15.0
Total CPUE = 37.9 (9; 568)
PSD = 27 (4)

2015

Effort = 15.0
Total CPUE = 14.8 (20; 222)
PSD = 26 (4)

2019

Effort = 15.0
Total CPUE = 9.5 (22; 142)
PSD = 12 (4)

Figure 4. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Houston, Texas, 2011, 2015, and 2019. Vertical line indicates minimum length limit.

Channel Catfish

2011

Effort = 15.0
Total CPUE = 24.3 (11; 365)
PSD = 18 (2)

2015

Effort = 15.0
Total CPUE = 18.9 (24; 284)
PSD = 11 (3)

2019

Effort = 15.0
Total CPUE = 11.1 (18; 167)
PSD = 16 (5)
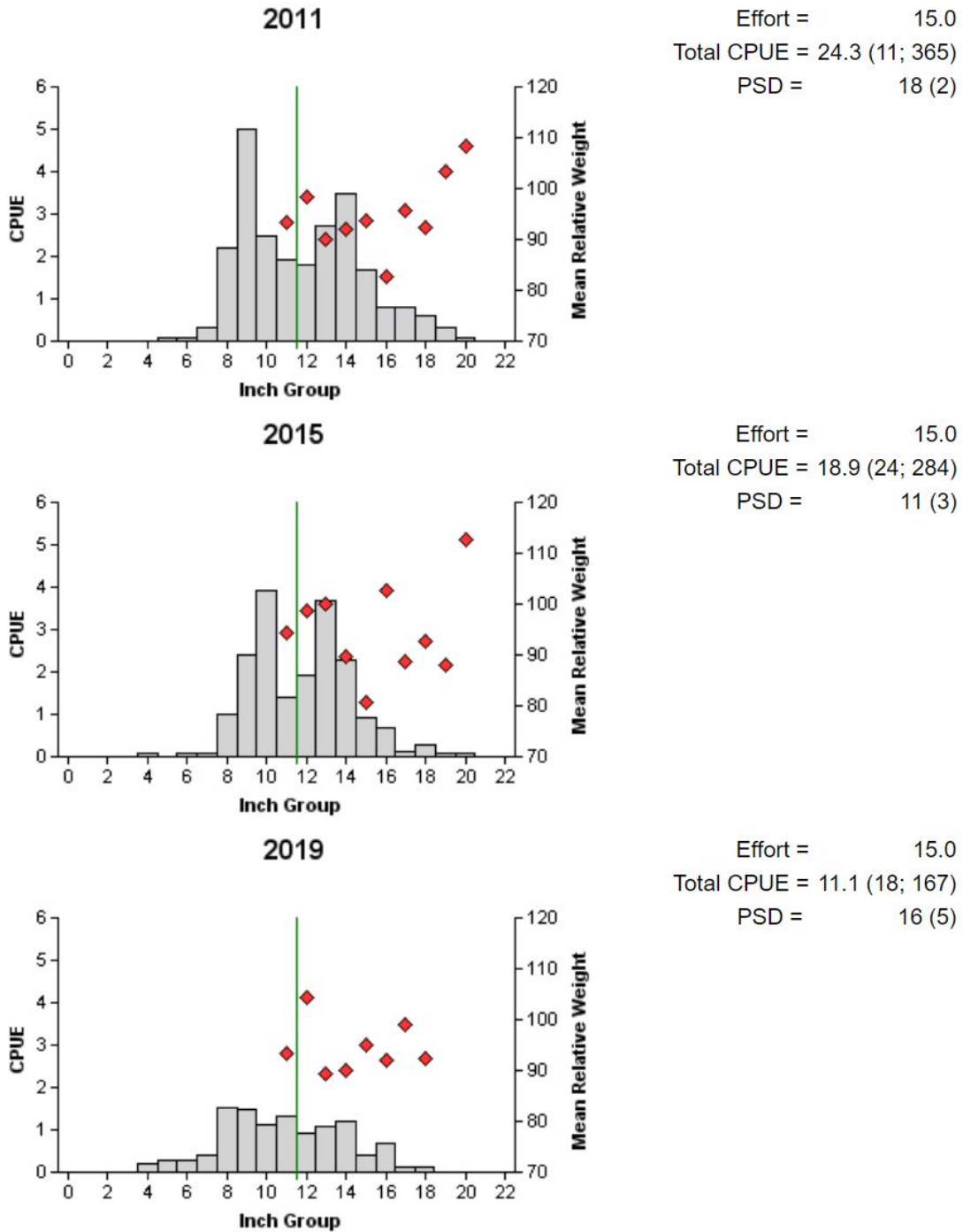
Figure 5. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Houston, Texas, 2011, 2015, and 2019. Vertical line indicates minimum length limit.

Table 10. Creel survey statistics for Blue Catfish and Channel Catfish at Lake Houston, Texas, from March 2011 through May 2011, March 2014 through May 2014, and March 2019 through May 2019. Total catch per hour is for anglers targeting Blue Catfish or Channel Catfish, and total harvest is the estimated number of Blue Catfish or Channel Catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year		
	2011	2014	2019
Surface area (acres)	10,160	10,160	10,160
Directed effort (h)	680.8 (61.7)	2,168.0 (49.8)	13,288.8 (35.5)
Directed effort/acre	< 0.1 (61.7)	0.2 (49.8)	1.3 (35.5)
Total catch per hour	1.6 (56.7)	0.1 (0.0)	0.6 (64.1)
Total harvest			
Blue Catfish	51.4 (198.5)	247.2 (330.5)	1,819.6 (100.7)
Channel Catfish	0 (0)	494.4 (229.9)	7,446.0 (46.1)
Harvest/acre			
Blue Catfish	< 0.1 (198.5)	< 0.1 (330.5)	0.2 (100.7)
Channel Catfish	0 (0)	< 0.1 (229.9)	0.7 (46.1)
Percent legal released			
Blue Catfish	0	17.1	0
Channel Catfish	100.0	0	0
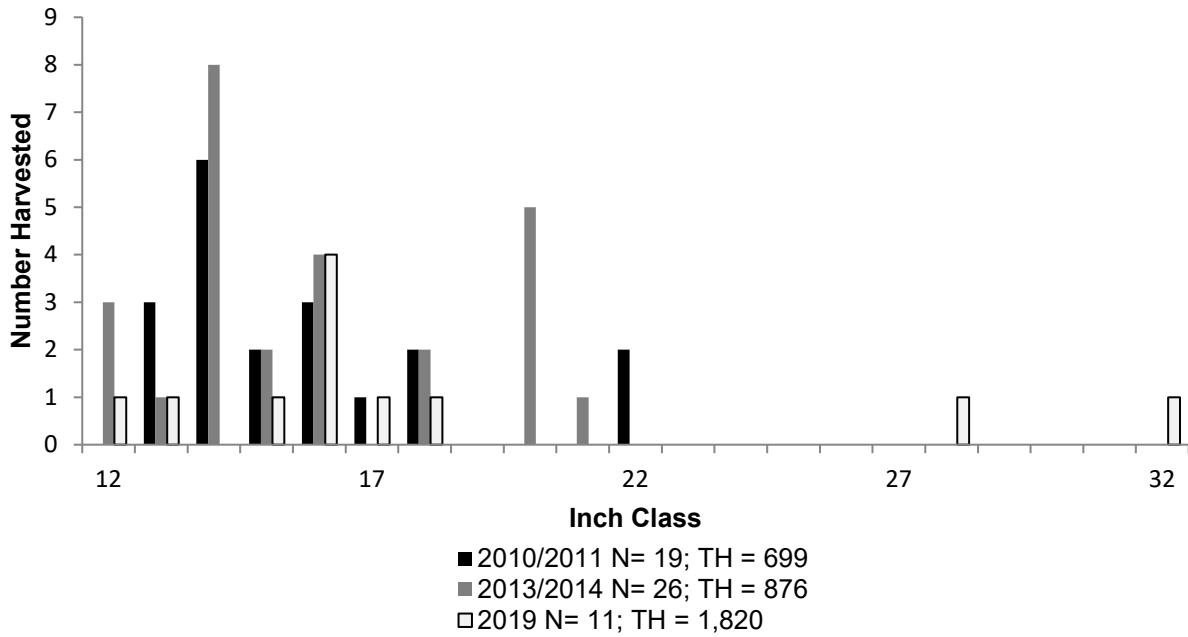
Figure 6. Length frequency of harvested Blue Catfish observed during creel surveys at Lake Houston, Texas, from June 2010 through May 2011, June 2013 through May 2014, and March 2019 through May 2019, all anglers combined. N is the number of harvested Blue Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.
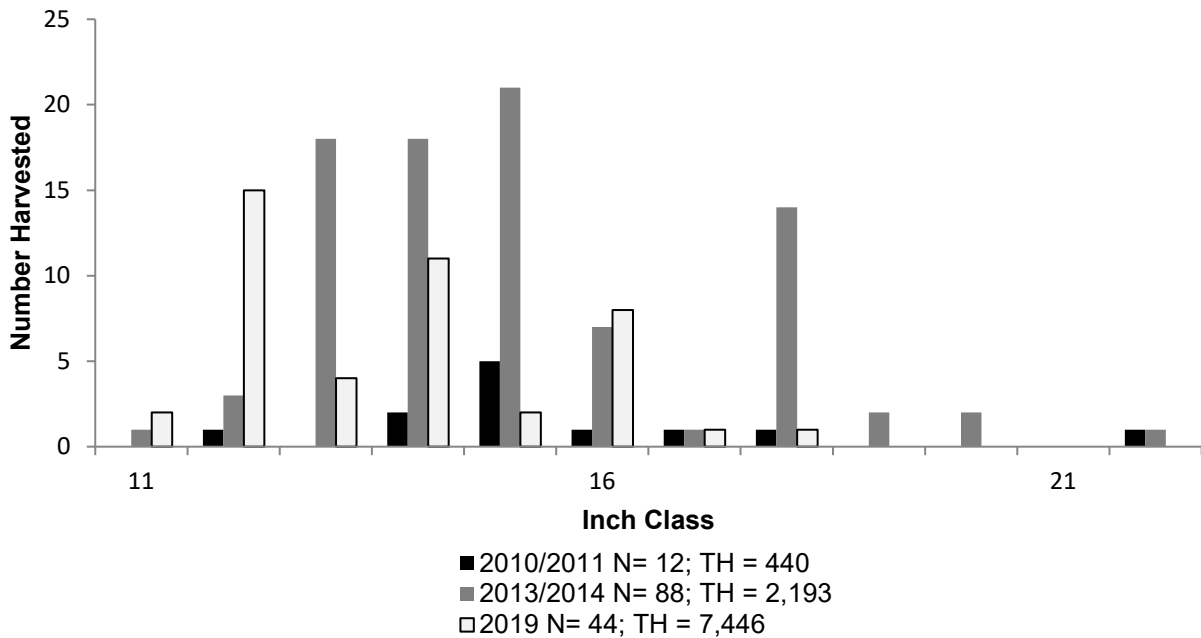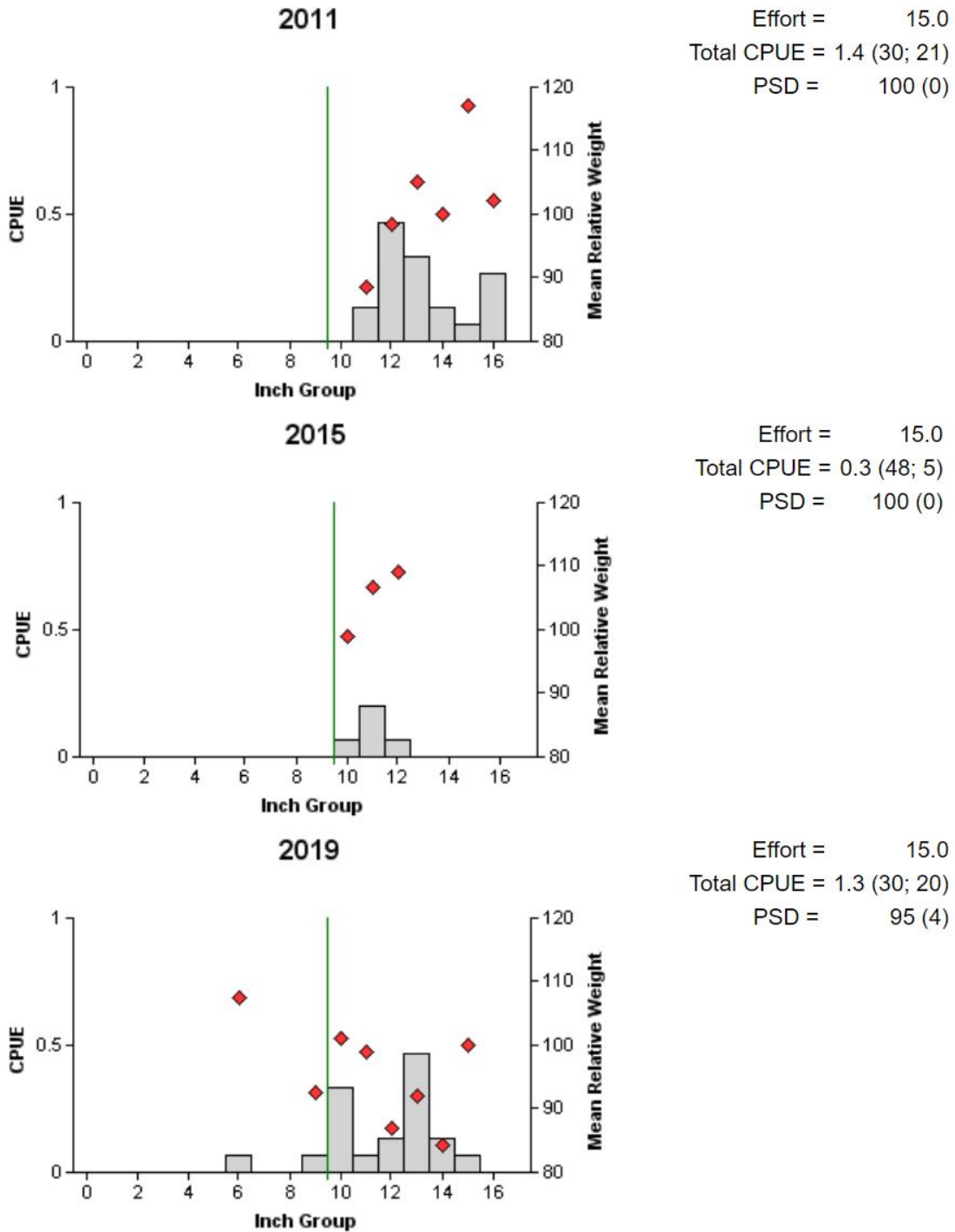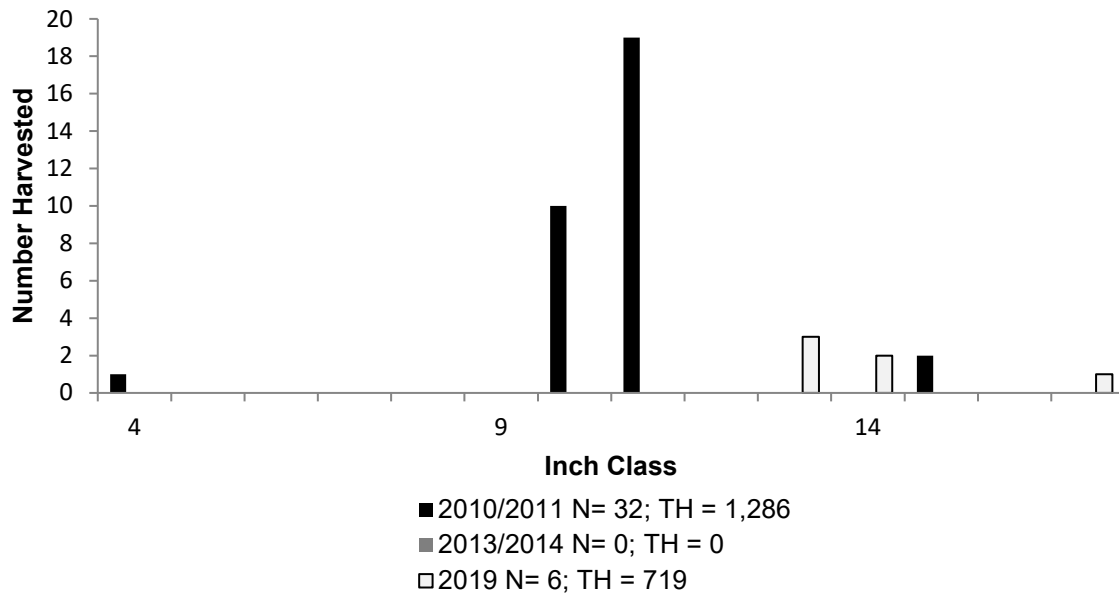

Figure 7. Length frequency of harvested Channel Catfish observed during creel surveys at Lake Houston, Texas, from June 2010 through May 2011, June 2013 through May 2014, and March 2019 through May 2019, all anglers combined. N is the number of harvested Channel Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.

White Bass

2011

Effort = 15.0
Total CPUE = 1.4 (30; 21)
PSD = 100 (0)

2015

Effort = 15.0
Total CPUE = 0.3 (48; 5)
PSD = 100 (0)

2019

Effort = 15.0
Total CPUE = 1.3 (30; 20)
PSD = 95 (4)

Figure 8. Number of White Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Houston, Texas, 2011, 2015, and 2019. Vertical line indicates minimum length limit.

Table 11. Creel survey statistics for White Bass at Lake Houston, Texas, from March 2011 through May 2011, March 2014 through May 2014, and March 2019 through May 2019. Total catch per hour is for anglers targeting White Bass and total harvest is the estimated number of White Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year		
	2011	2014	2019
Surface area (acres)	10,160	10,160	10,160
Directed effort (h)	0 (0)	0 (0)	0 (0)
Directed effort/acre	0 (0)	0 (0)	0 (0)
Total catch per hour	NA*	NA*	NA*
Total harvest	51.4 (151.6)	0 (0)	718.5 (168.4)
Harvest/acre	< 0.1 (151.6)	0 (0)	< 0.1 (168.4)
Percent legal released	0	0	8.1

*No directed effort.

Figure 9. Length frequency of harvested White Bass observed during creel surveys at Lake Houston, Texas, from June 2010 through May 2011, June 2013 through May 2014, and March 2019 through May 2019, all anglers combined. N is the number of harvested White Bass observed during creel surveys, and TH is the total estimated harvest for the creel period.
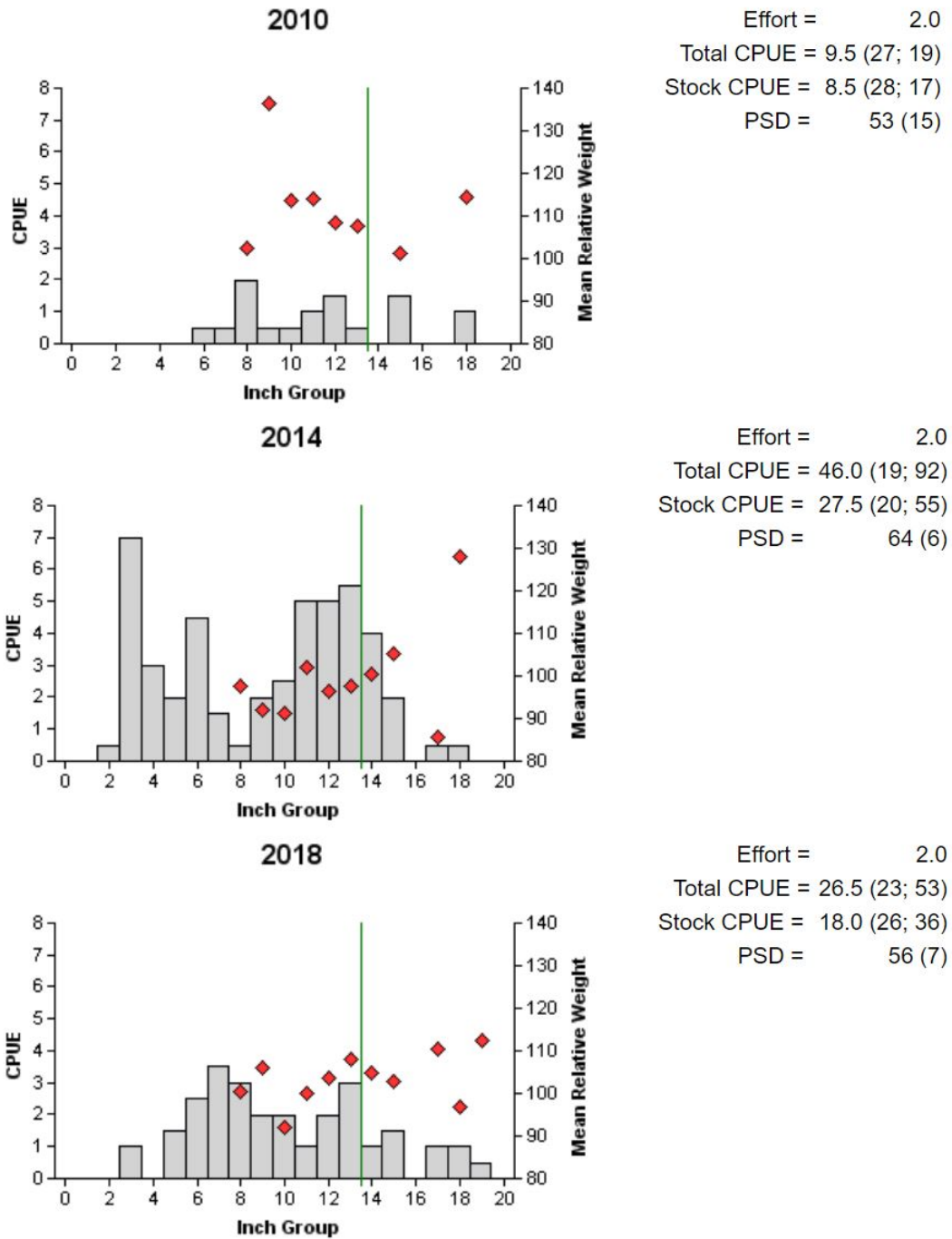
Largemouth Bass

2010

2014

2018

Figure 10. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Lake Houston, Texas, 2010, 2014, and 2018. The 2010 sample was randomly selected nighttime electrofishing, while 2014 and 2018 were biologist-selected daytime sampling. Vertical line indicates minimum length limit.
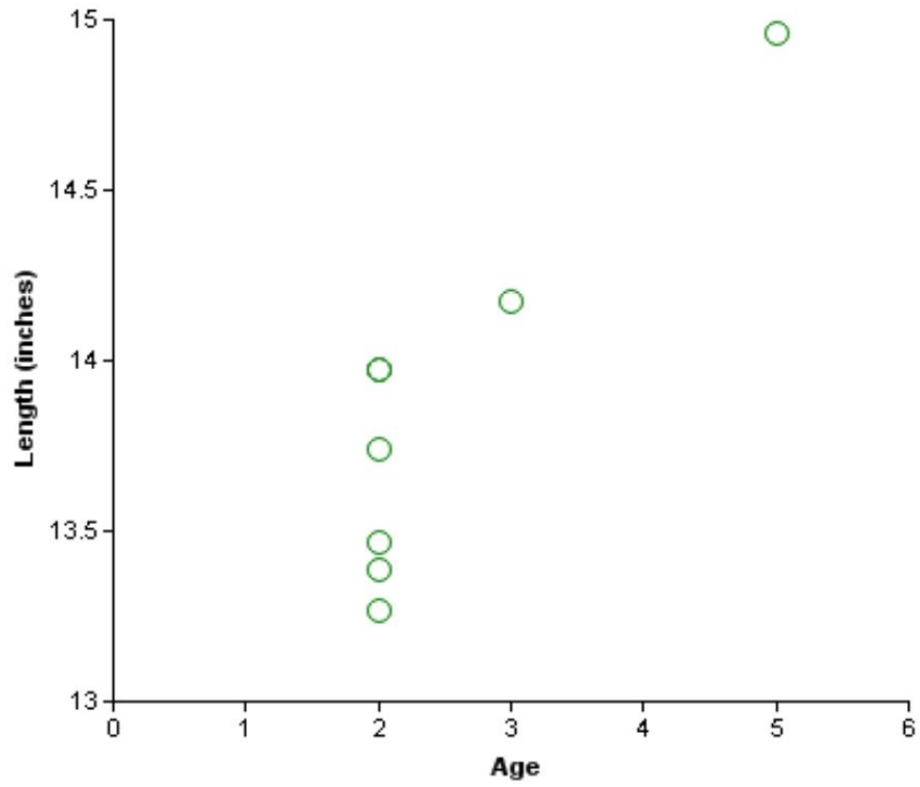
Figure 11. Length at age for Largemouth Bass collected from fall daytime electrofishing at Lake Houston, Texas, 2018.

Table 12. Creel survey statistics for Largemouth Bass at Lake Houston, Texas, from March 2011 through May 2011, March 2014 through May 2014, and March 2019 through May 2019. Catch rate is for all anglers targeting Largemouth Bass. Harvest is partitioned by the estimated number of fish harvested by non-tournament anglers and the number of fish retained by tournament anglers for weigh-in and release. The estimated number of fish released by weight category is for anglers targeting Largemouth Bass. Relative standard errors (RSE) are in parentheses.

| Statistic	2011	2014	2019
Surface area (acres)	10,160	10,160	10,160
Directed angling effort (h)			
Tournament	828.8 (57.6)	0 (0)	435.3 (114.4)
Non-tournament	1,871.8 (45.2)	2,808.8 (41.6)	6,166.5 (49.1)
All black bass anglers combined	2,700.6 (49.0)	2,808.8 (41.6)	6,601.8 (53.5)
Angling effort/acre	0.3 (49.0)	0.3 (41.6)	0.6 (53.5)
Catch rate (number/h)	1.8 (29.5)	3.5 (28.5)	2.4 (3.2)
Harvest			
Non-tournament harvest	77.1 (99.1)	1,730.4 (57.4)	0 (0)
Harvest/acre	< 0.1 (99.1)	0.2 (57.4)	0 (0)
Tournament weigh-in and release	154.2 (107.0)	0 (0)	0 (0)
Release by weight			
<4.0 lbs	NA	3,101 (45.2)	3,800 (125.0)
4.0-6.9 lbs	NA	0 (0)	760 (123.8)
7.0-9.9 lbs	NA	0 (0)	0 (0)
≥10.0 lbs	NA	0 (0)	0 (0)
Percent legal released (non-tournament)	87.6	58.8	100.0
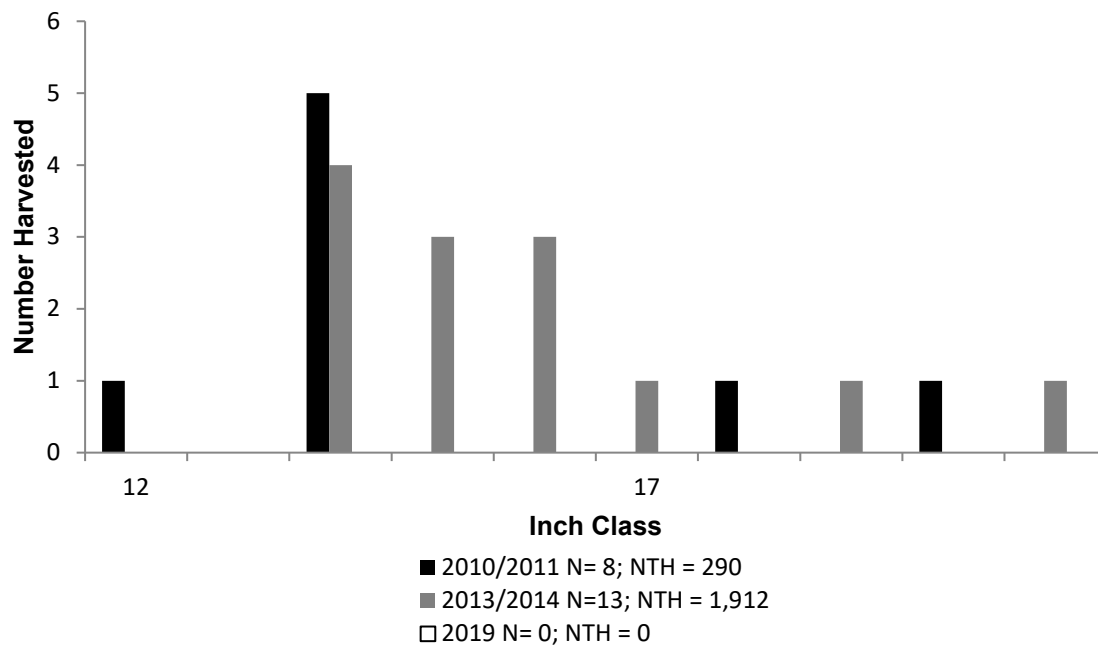
Figure 12. Length frequency of non-tournament harvested Largemouth Bass observed during creel surveys at Lake Houston, Texas, from June 2010 through May 2011, June 2013 through May 2014, and March 2019 through May 2019, all anglers combined. N is the number of harvested Largemouth Bass observed during creel surveys, and NTH is the estimated non-tournament harvest for the creel period.

Table 13. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Lake Houston, Texas, 2011, 2014, and 2018. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, F1 = first generation hybrid between a FLMB and a NLMB, Fx = second or higher generation hybrid between a FLMB and a NLMB. Genetic composition was determined with micro-satellite DNA analysis.

| Year | Sample size | Number of fish | | | | % FLMB alleles | % pure FLMB |
		FLMB	F1	Fx	NLMB		
2011	30	0	1	18	11	8	0
2014	30	0	1	18	11	12	0
2018	29	1	0	16	12	13	3

White Crappie

2002

Effort = 15.0
Total CPUE = 5.3 (30; 79)
PSD = 69 (8)

2014

Effort = 15.0
Total CPUE = 16.3 (23; 244)
PSD = 30 (8)

2018

Effort = 15.0
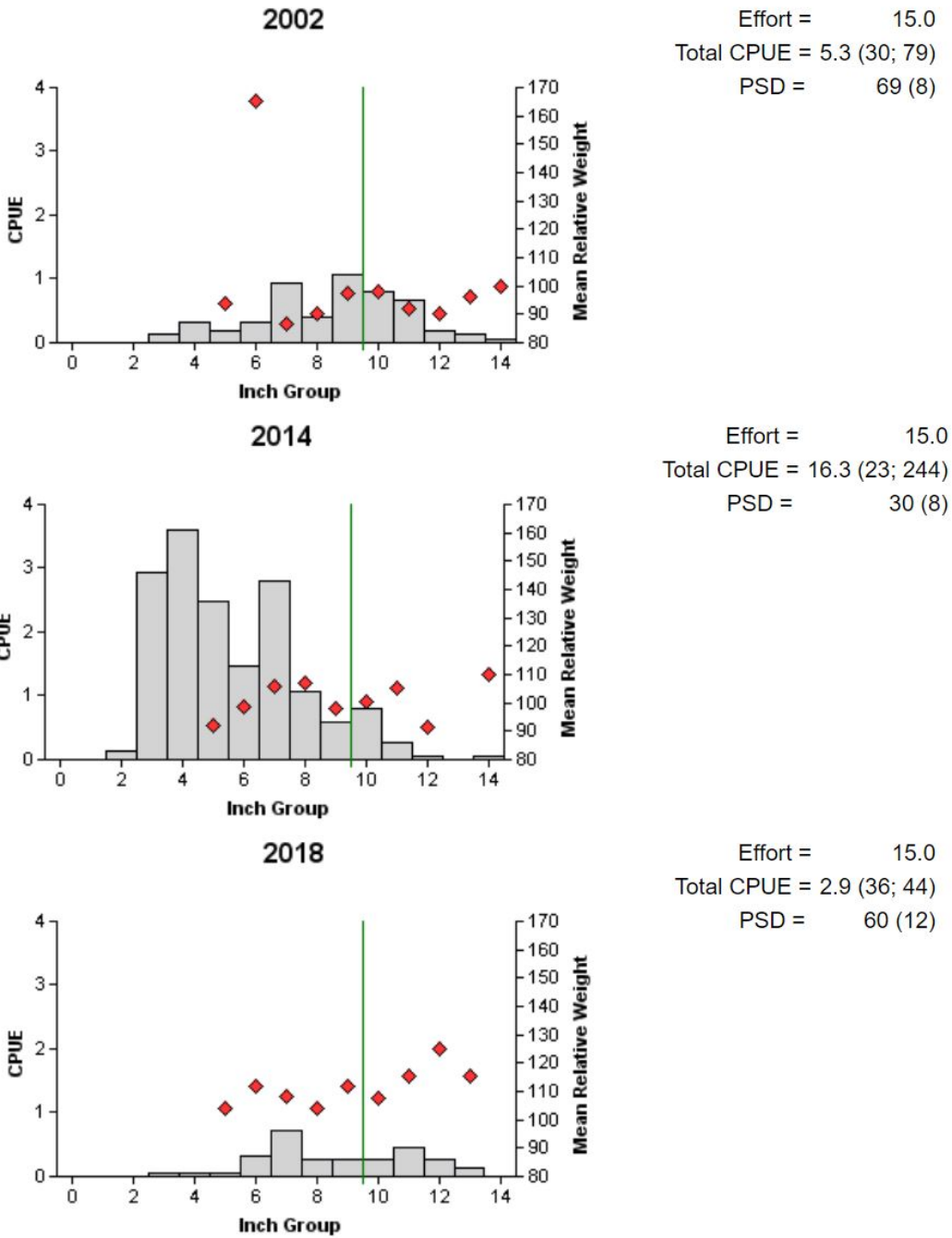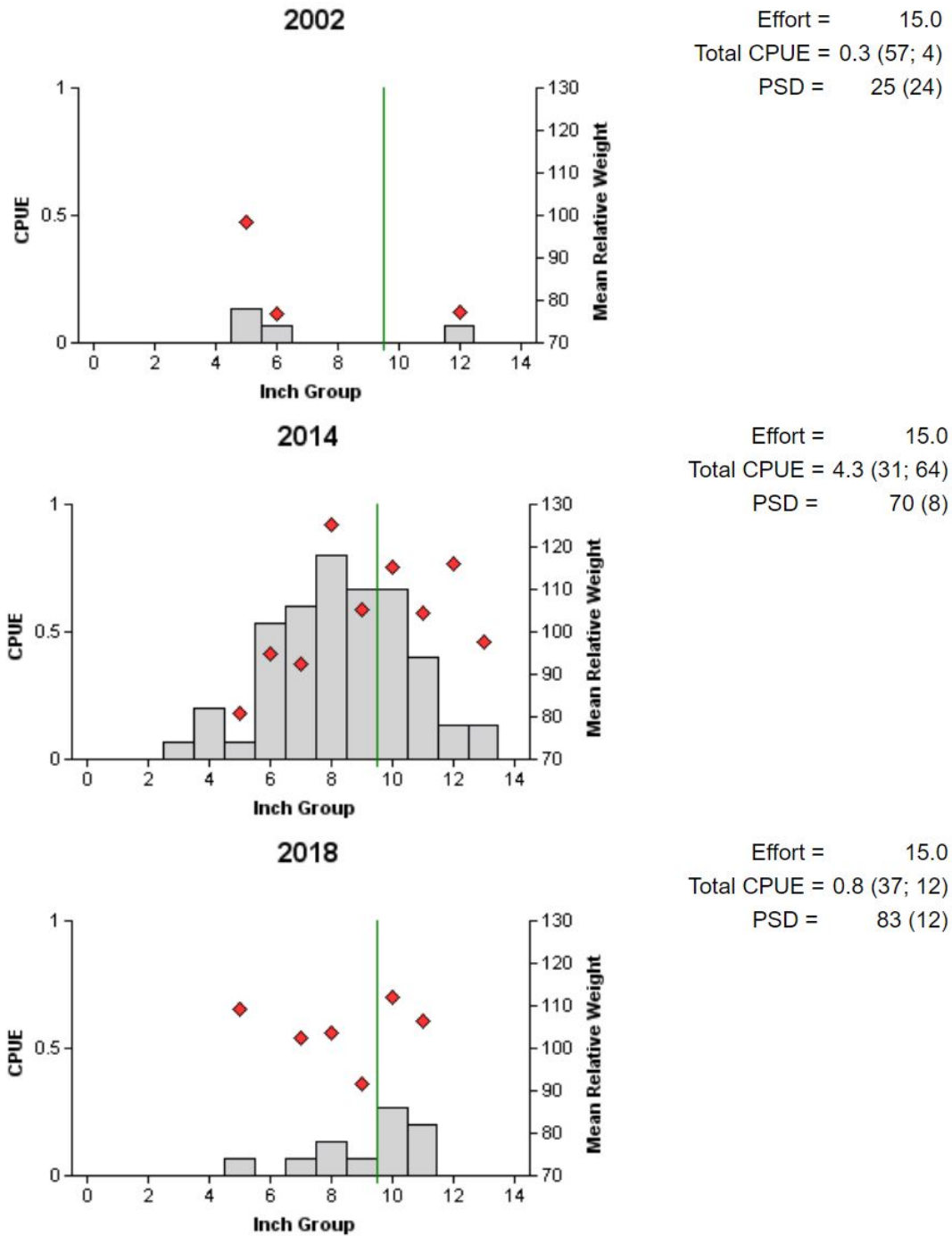Total CPUE = 2.9 (36; 44)
PSD = 60 (12)

Figure 13. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap netting surveys, Lake Houston, Texas, 2002, 2014, and 2018. Vertical line indicates minimum length limit.
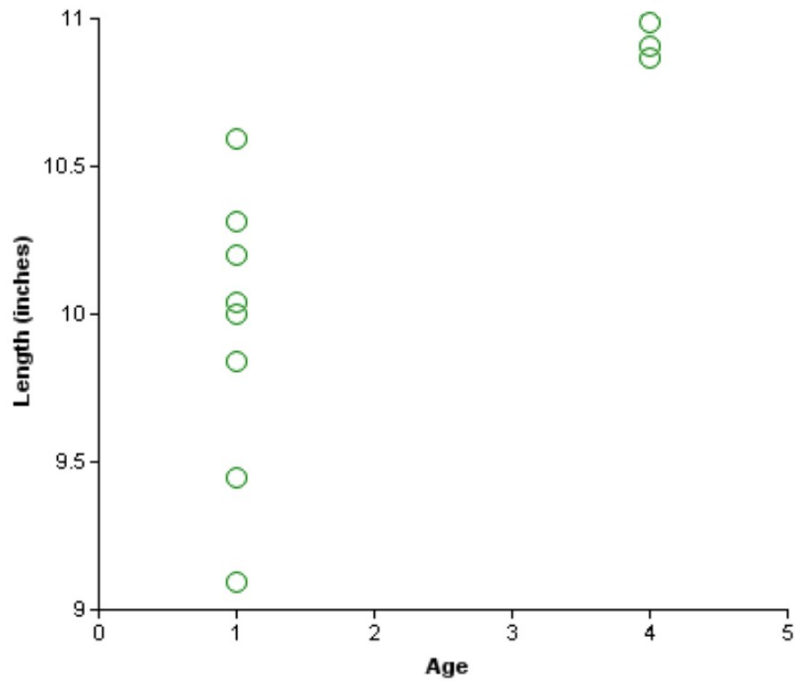
Black Crappie

2002

Effort = 15.0
Total CPUE = 0.3 (57; 4)
PSD = 25 (24)

2014

Effort = 15.0
Total CPUE = 4.3 (31; 64)
PSD = 70 (8)

2018

Effort = 15.0
Total CPUE = 0.8 (37; 12)
PSD = 83 (12)

Figure 14. Number of Black Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap netting surveys, Lake Houston, Texas, 2002, 2014, and 2018. Vertical line indicates minimum length limit.

Figure 15. Length at age for White Crappie collected from fall trap netting and fall daytime electrofishing at Lake Houston, Texas, 2018.
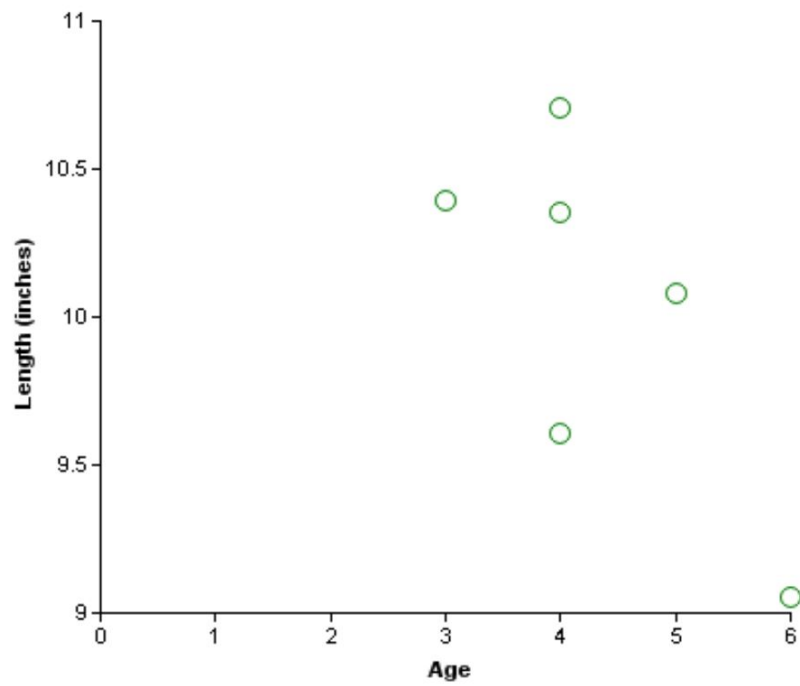
Figure 16. Length at age for Black Crappie collected from fall trap netting and fall daytime electrofishing at Lake Houston, Texas, 2018.

Table 14. Creel survey statistics for crappies at Lake Houston, Texas, from March 2011 through May 2011, March 2014 through May 2014, and March 2019 through May 2019. Total catch per hour is for anglers targeting crappies, and total harvest is the estimated number of White Crappie or Black Crappie harvested by all anglers. Relative standard errors (RSE) are in parentheses.

| Creel Survey Statistic	Year		
	2011	2014	2019
Surface area (acres)	10,160	10,160	10,160
Directed effort (h)	12,121.2 (36.3)	462.4 (104.6)	26,875.2 (33.0)
Directed effort/acre	1.2 (36.3)	< 0.1 (104.6)	2.6 (33.0)
Total catch per hour	0.4 (48.5)	1.2 (100.0)	0.9 (19.9)
Total harvest			
White Crappie	616.7 (81.7)	3,708.1 (42.8)	11,280.1 (49.2)
Black Crappie	77.1 (167.0)	0 (0)	2,514.8 (79.6)
Harvest/acre			
White Crappie	< 0.1 (81.7)	0.4 (42.8)	1.1 (49.2)
Black Crappie	< 0.1 (167.0)	NA	0.2 (79.6)
Percent legal released			
White Crappie	11.7	0	2.2
Black Crappie	0	0	0
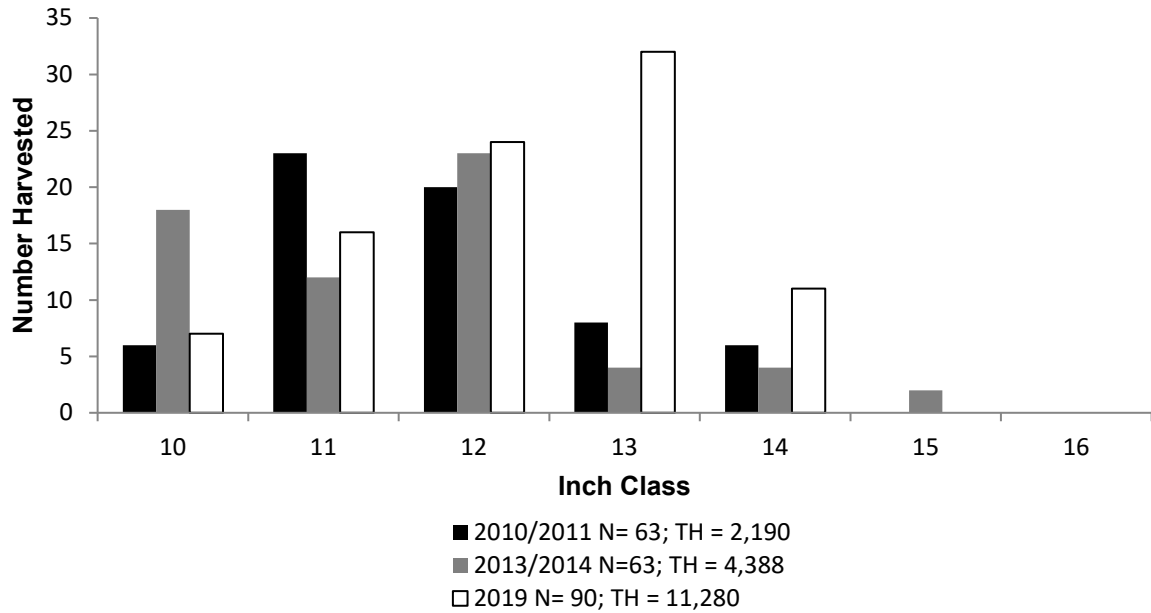
Figure 17. Length frequency of harvested White Crappie observed during creel surveys at Lake Houston, Texas, from June 2010 through May 2011, June 2013 through May 2014, and March 2019 through May 2019, all anglers combined. N is the number of harvested White Crappie observed during creel surveys, and TH is the total estimated harvest for the creel period.
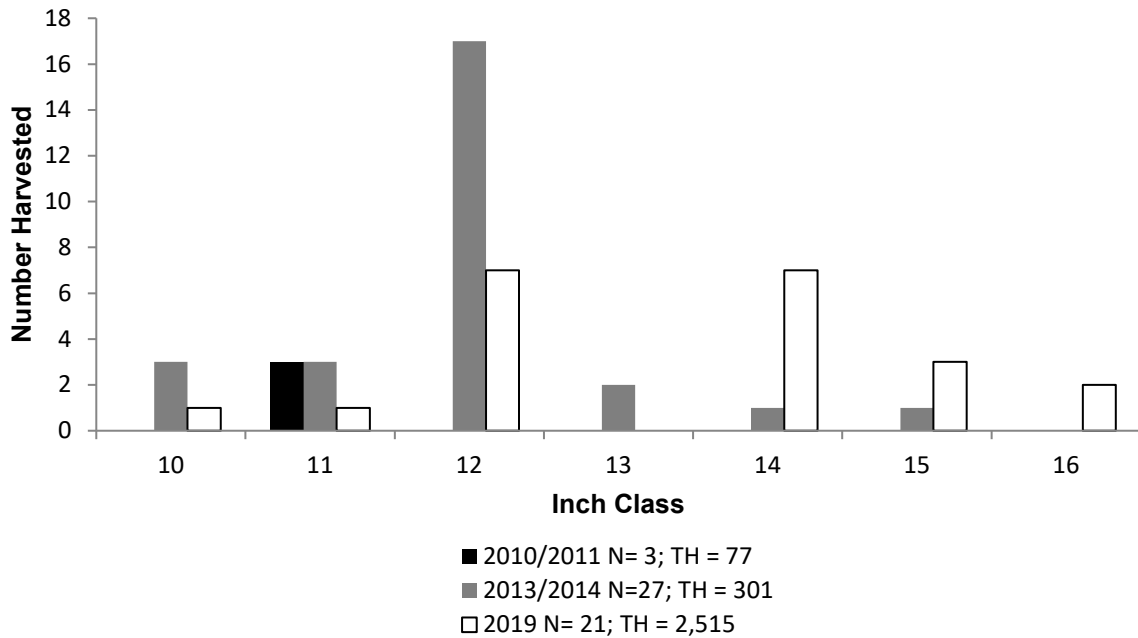

Figure 18. Length frequency of harvested Black Crappie observed during creel surveys at Lake Houston, Texas, from June 2010 through May 2011, June 2013 through May 2014, and March 2019 through May 2019, all anglers combined. N is the number of harvested Black Crappie observed during creel surveys, and TH is the total estimated harvest for the creel period.

Proposed Sampling Schedule

Table 15. Proposed sampling schedule for Lake Houston, Texas. Survey period is June through May. Gill netting surveys are conducted in the spring, while electrofishing and trap netting surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A.

	Survey year			
	2019-2020	2020-2021	2021-2022	2022-2023
Angler Access				S
Structural Habitat				S
Vegetation	A	A	A	S
Electrofishing – Fall				S
Trap Netting				S
Gill Netting				S
Creel Survey – Spring Quarter				A
Report				S

APPENDIX A – Catch rates for all species from all gear types

Number (N) and catch rate (CPUE) (RSE in parentheses) of all species collected from all gear types from Lake Houston, Texas, 2018-2019. Sampling effort was 15 net nights for gill netting, 15 net nights for trap netting, and 2 hours for electrofishing.

Species	Gill Netting		Trap Netting		Electrofishing	
	N	CPUE	N	CPUE	N	CPUE
Gizzard Shad	133	8.9 (24)			192	96.0 (23)
Threadfin Shad					1386	693.0 (32)
Weed Shiner					1	0.5 (100)
Common Carp	3	0.2 (72)				
Bullhead Minnow					25	12.5 (43)
Inland Silverside					59	29.5 (31)
Brook Silverside					16	8.0 (33)
Blacktail Shiner					4	2.0 (69)
Spotted Sucker	2	0.1 (68)			4	2.0 (59)
Blue Catfish	142	9.5 (22)			1	0.5 (100)
Channel Catfish	167	11.1 (18)			7	3.5 (44)
White Bass	20	1.3 (30)				
Yellow Bass	40	2.7 (35)			2	1.0 (69)
Green Sunfish					4	2.0 (59)
Warmouth					6	3.0 (43)
Bluegill	1	0.1 (100)			120	60.0 (31)
Longear Sunfish					157	78.5 (41)
Redear Sunfish					8	4.0 (47)
Largemouth Bass					53	26.5 (23)
White Crappie	9	0.6 (48)	44	2.9 (36)	16	8.0 (45)
Black Crappie			12	0.8 (37)	9	4.5 (48)
Freshwater Drum	56	3.7 (24)				
Etheostoma spp.					1	0.5 (100)
Hybrid Tilapia					26	13 (35)

APPENDIX B – Map of sampling locations
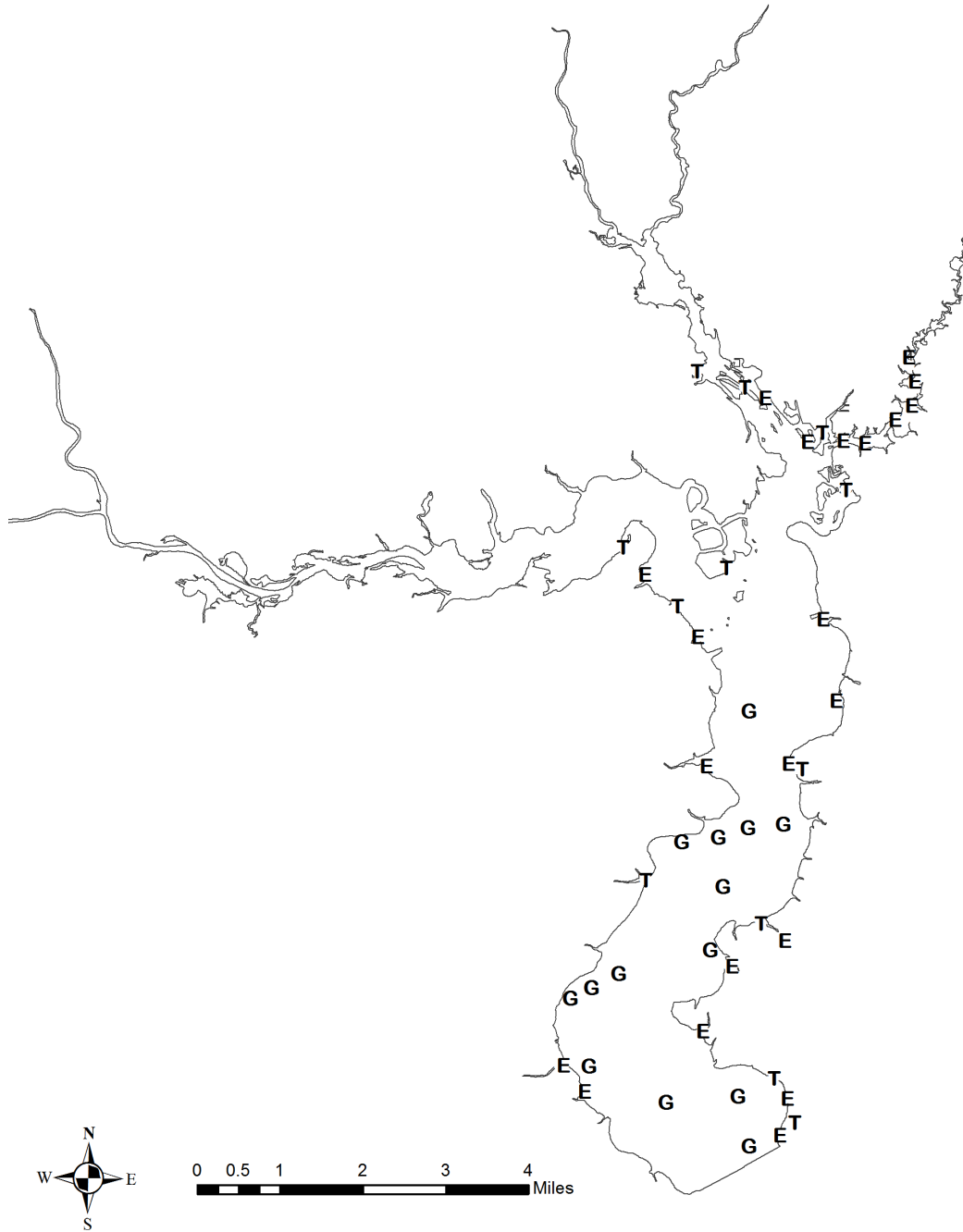
Location of sampling sites, Lake Houston, Texas, 2018-2019. Trap net, gill net, and electrofishing stations are indicated by T, G, and E, respectively. Water level was near full pool at time of sampling.

APPENDIX C – Reporting of creel ZIP code data

Frequency Count

1 - 2	3 - 5	6 - 8	9 - 19	20 - 34
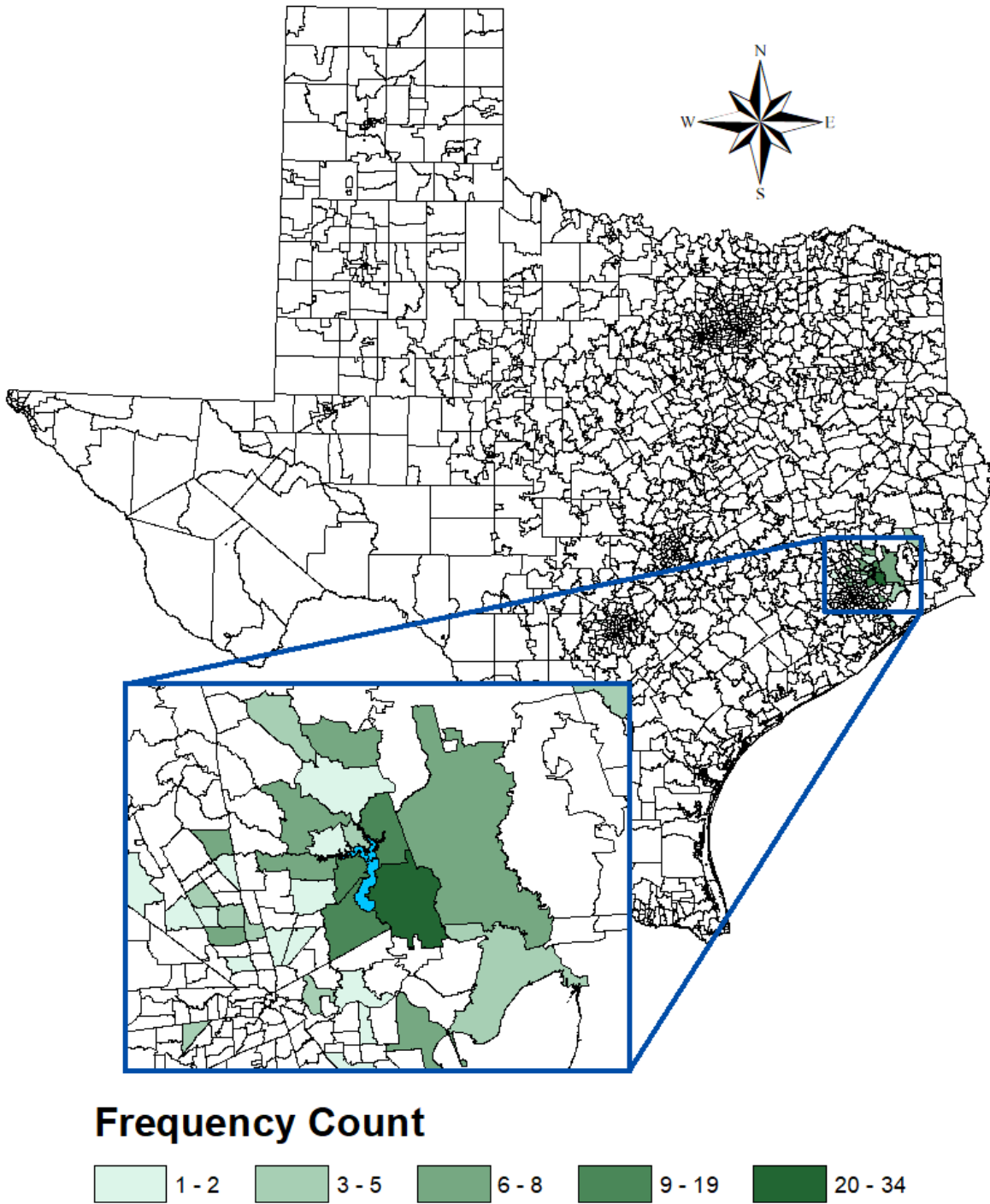
Location, by ZIP code, and frequency of anglers that were interviewed at Lake Houston, Texas, during the March 2019 through May 2019 creel survey.

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